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ABSTRACT

This experimental study was conducted in an attempt to determine how children--four, seven, and 11 years old--perceive implied motion cues in combination with a variety of objects. Ninety children, 30 in each age group, were shown 24 pictures. There were three kinds of objects, each with an inherent active and static dimension. Each of these six pictures appeared with one of three motion cues, and alone. The number of each of the picture styles identified as moving by each subject was determined. An age x object x activity x motion cues repeated measures ANOVA was used to evaluate the data. All main effects and all interactions were significant. It was concluded that children at different stages of development differ in their interpretation of certain graphic conventions. A list of references is attached. (Author/RAO)

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CHILDREN'S UNDERSTANDING OF IMPLIED MOTION CUES

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ABSTRACT

Children's Understanding of Implied Motion Cues
Ronald A. Saiet

Extrapolating from Piaget's theory of cognitive development it can be argued that graphic conventions such as flow lines and vibration marks used by artists to depict motion would have little or no meaning to pre-school children, but that an action pose, being more like real human posture, would be a symbol within the grasp of understanding of children in this group. By age seven, most children should be capable of understanding arbitrary graphic symbols, and by age eleven virtually all should be capable.

The kind of object upon which a motion cue is said to act might also affect perception of movement. Human figures, for example, might appear to be more likely to be in motion than abstracted geometric shapes. An inherent motion factor may also be said to reside within an object, such that it psychologically appears to be more active or more static--running figures, ellipses, and rectangles may be seen as more active than standing figures, circles or squares.

An experimental study was conducted in an attempt to determine how children --four, seven, and eleven years old--perceive implied motion cues in combination with a variety of objects. Ninety children, 30 in each age group, were shown 24 pictures. There were three kinds of objects, each with an inherent active and static dimension. Each of these six pictures appeared with one of three motion cues, and alone. The number of each of the picture types identified as moving by each subject was determined. An age x object x activity of object x motion cues repeated measures ANOVA was used to evaluate the data.

All main effects and all interactions were significant. It was concluded that children at different stages of development differ in their interpretation of certain graphic conventions. Illustrators, editors, and publishers should take into account the pictorial literacy of an intended audience when they design materials to convey motion information.

"Of all the senses, trust only the sense of sight."
Aristotle, Metaphysics

Little more than a decade ago, Fleming (1966) observed that in the midst of new trends emerging in educational technology, the commonplace print media continued largely unchallenged as the most widely used educational resource (p. 299). He also found a proliferation of illustrations in textbooks, one illustration appearing every 1.58 pages of 40 eighth grade texts sampled (p. 317). Casual observation of textbook offerings in children's literature today reveals that the situation now appears to be much as it was then, and one continues to wonder along with Fleming what essential role illustrations serve; they add to the size and costs of printed materials, but is there any evidence that pictures add to a child's understanding of the matter before him?

Gropper (1963) observed that much less is known about how people respond to visuals than about how people respond to words. Art students are taught what Dondis (1973) called the basic elements of visual communication--dot, line, shape, direction, tone, color, texture, dimension, scale, and movement (pp. 39-66)--but Hengen (1970) asked whether children have acquired an understanding of these elements, and if so, whether they are acquired through talent or through training (p. 3). The present writer's survey of the literature has found it wanting in questions and answers about how people--children and adults--perceive and learn from non-verbal,

non-moving visual stimuli.

The problem for message designers was stated by Fleming as follows: "It is improbable that an instructional system can approximate optimum performance unless the designer of that system is fully informed on the relevant characteristics of the system component options. Pictorial stimuli will be one of the system component options the designer will select to meet certain system specifications" (1966, pp. 317-318).

It is the aim of this paper to examine a small part of this problem within the area of pictorial communication. The investigation carried out here was suggested by a doctoral dissertation by Satterthwaite (1965), "An investigation of selected cues for implying motion in non-motion media." It was Satterthwaite's assumption that graphic devices (called "implied motion cues") commonly used in two-dimensional print media by artists and illustrators sucessfully transmit some motion information to the perceivers of these graphic devices. He then selected and manipulated three such implied motion cues*, and asked "Do all of the possible variations of these implied motion cues transmit the same motion information or are some combinations of cues and objects best suited for the transmission of certain types of motion information?" (pp. 20-25) Using 40 subjects, all students enrolled in a graduate course in Audio-Visual Communications at Indiana University, Satterthwaite's basic

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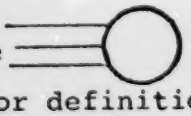
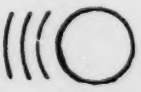
* 1. Flow line  2. Action line  3. Action pose

(See page 7 for definitions.)

assumption that the cues successfully implied motion was upheld and the answer to his basic question was that certain variations and combinations of cues and objects did affect the communication differentially (pp. 123-126).

It is not surprising, at least to this investigator, that students in a graduate audio-visual course understood the intention of the implied motion cues. They especially would seem likely to have encountered such cues in their lifetimes and to have assigned accurate meanings to them (accurate because their interpretation was congruent with the designer's intended meaning). It is not surprising, either, that even this group of subjects did not all interpret the variations of the cues in the same way, because most of Satterthwaite's variations (i.e.; long/short, thick/thin, and others*) do not have universal meaning, were never systematically taught or learned by the subjects, and are arbitrary in nature. As Knowlton (1966) observed, a sign's ability to signify a concept is dependent upon the concept's having already been attained by its interpreter (p. 165). Fat and thin lines intended to imply more or less speed, for example, are arbitrary signs within this context, and have to be learned if other than idiosyncratic interpretations are to be given.

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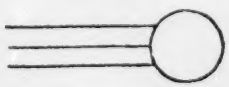
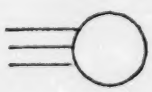
1. long flow line 

2. short flow line 

3. thick flow line

4. thin flow line

People are not born literate. Through a combination of factors--development, experience, formal education--people eventually learn to decode visual messages. The basic alternative question to Satterthwaite's which is to be posed then, is <u>when</u> do graphic devices effectively transmit motion information? Put another way, at what stage of development do children accurately perceive visual cues designed to imply motion from non-moving pictorial stimuli?

According to Piaget's theory of cognitive development one either assimilates new information into an already existing mental category (psychological structure) as something like or unlike something already understood, or one accommodates and changes his mental structure--creates a new category--to deal with information which cannot be so assimilated. Furthermore, each child proceeds through a series of stages, each stage represented by the presence of particular psychological structures. Since experience is always changing, new structures are always evolving, with the result that adult structures are more sophisticated than those available to children. Highly evolved adult intelligence is represented by more assimilation into existing, well developed structures whereas learners at earlier stages of development, not having yet evolved the necessary structures present at later stages of cognitive development, are prone to misinterpret (or ignore) information.

If a child perceives a pictorial element as familiar, he will be able to process it, to make sense of it. If on

the other hand, he is unable to recognize a pictorial element--person, place, thing, or action--this might be construed as an indication of his picture illiteracy. An implied motion cue, if not within the range of a child's experience, would be incomprehensible to him. A viewer at a higher level of picture literacy, possessing only partial literacy, would make sense of some parts of pictures but would misinterpret the meaning of the entire pictorial message; if a single cue is misinterpreted, meaning is incomplete. Attained picture literacy would be evidenced by one's ability to correctly interpret complex visual symbols, abstractions, and graphic conventions.

Considering the expense publishers incur in creating illustrative materials, it would seem to be useful to them to know at what stages of development their audiences are--their level of picture literacy--so that the pictorial information can be made to be appropriate to each audience. One might assume that an American child, even at age four, will recognize pictorial representations of a familiar object because of his experience with television, film, and books. But it is another matter to predict with any accuracy at what age he will be able to infer motion from two-dimensional motion conventions. It seems plausible, however, that as children get older they recognize the intended meaning of certain cues; that certain motion cues will be perceived more often as containing motion information by children as they mature; and that inherent characteristics

(such as shape and life-likeness) of objects purported to be in motion affect the communicative power of motion cues as perceived by children at different stages of development.

The study undertaken by the current writer investigates the problem of when and how children at different stages of development understand implied motion cues. The current vehicle of presentation precludes a more thorough review of the relevant, albeit limited, literature. For additional explication of Piaget's theory relevant to the current exloration, see Ginsberg & Opper (1969), Phillips (1975), Rohwer, Ammon & Cramer (1974), and Wadsworth (1971). Research conducted by the High/Scope Educational Research Foundation (Banet, et. al., and Nederveid & Thomson, 1972) into children's undertanding of representative material and the implications for learning is useful, and Friedman & Stevenson's study of developmental changes and their affect on understanding of implied motions cues (1975) provides an alternative experimental approach utilizing an interesting array of stimulus materials, and was most useful in developing the current study.

Problem and Methodology

Problem

This study was designed to find out how children--4, 7, and 11 years old--perceive selected implied motion cues. The implied motion cues selected for this study were the flow line, the vibration mark, and the blur. The drawings used were selected by three judges (graphic artists) according to two criteria: they had to be similar to the postural characters and cartoon devices used in Friedman and Stevenson (1975), and they had to convey motion information to them (i.e., to the judges).

Definitions

Implied motion cues...those graphic devices commonly used to represent motion in non-motion media (i.e., children's books, textbooks, magazines, and newspapers).

Flow line.....a graphic device used to imply speed, it consists of even, clearly spaced, parallel lines that extend horizontally from the trailing edge of the object purported to be in motion.

Vibration mark.....a graphic device used to imply erratic movement, it consists of short lines which echo a part of the figure purported to be in motion.

Blur.....a graphic device used to indicate great speed, it consists of a shaded area extending from the trailing edge of the figure purported to be in motion.

Action pose.....Satterthwaite defines the action pose as an implied motion cue "which is an integral part of the object itself" (1965, p. 18). It consists of a representation of a human figure in profile with its body and limbs arranged in a manner deviating from a strictly vertical, standing position. For the purposes of statistical treatment in this study, however, the action pose is regarded as an active object, not as a motion cue per se.

The objective of this study was to measure motion perception of subjects in three age groups (four, seven, and eleven year olds), corresponding to Piaget's pre-operational through concrete operational periods, to determine whether (a) the implied motion cues are perceived, whether (b) there is an hierarchical order of identification of the selected cues, and whether (c) the configuration of the object purported to be seen as moving affects the perception of motion. The configuration of object type may be said to contain two dimensions, shape and activity.

The questions, then, which guided this study were:

1. Do children at different developmental levels attend to implied motion cues, and do they read them as motion devices?

2. Is one selected implied motion cue perceived more often as containing motion information than is another selected implied motion cue by children as they advance from the pre-operational stage to the concrete operations stage?

3. Do certain inherent characteristics of the kind of objects being acted upon differentially affect the communicative power of selected implied motion cues as reported by children as they mature from the pre-operational to the concrete operations stage?

The last of these questions requires some additional consideration. Both Satterthwaite, and Friedman and Stevenson (1975) found the nature and configuration of the object critical to the question of motion perception in non-motion media. Each study found that active, postural figures were full of motion information for all of their subjects, regardless of the conventional cues applied. Friedman and Stevenson did not, however, include geometric figures in their study. Satterthwaite did, but found no perceivable differences in the speed of active or static geometric figures, although rounded objects were seen as moving faster than angular objects.

This study attempted to examine all three kinds of objects--human figures (postural), angular geometric, and rounded geometric--to assess their interaction with the motion cues selected for this study and with subjects at their various stages of development. Additionally, an active and static object were presented for each kind of object. The objects may be classified as in Figure 1.

	Active	Static	Human figure	Geometric, angular	Geometric, rounded
Running figure	X		X		
Standing figure		X	X		
Rectangle	X			X	
Square		X		X	
Ellipse	X				X
Circle		X			X

Figure 1. Classification of kinds of objects.

Methodology

Subjects. In this study there were 30 four year olds, 30 seven year olds, and 30 eleven year olds. They were selected arbitrarily from the National College of Education Baker Demonstration School, and the Martin Luther King, Jr., Laboratory School in Evanston, Illinois. The subjects were primarily from middle to upper-middle class families.

Materials. A series of 24 cards served as the stimulus materials. Each card contained one illustration of one of six objects: circle, ellipse, square, rectangle, running figure, and standing figure. The objects were of three kinds: human figures, angular geometric figures, and rounded geometric figures. There were two dimensions of each object type: active and static. The active human object was repre-

sented by a running figure. The static human object was represented by a standing figure. The active angular geometric object was represented by a rectangle. The static angular geometric object was represented by a square. The active rounded geometric object was represented by an ellipse. The static rounded geometric object was represented by a circle. Three implied motion cues were added to one picture of each object, and one picture of each object stood without any implied motion cue, for a total of 24 pictures. The selected implied motion cues were the flow line, vibration mark, and blur. Figure 2 illustrates the 24 pictures.

Procedures. First, the four year olds were screened to ascertain their grasp of the concept of real movement. They were asked to stand still, to run, to jump, to move a "little bit", to "shiver and shake like when you are cold." They were then given a doll, a ball, a rectangular block, a square block, and an elliptical block and asked if each was moving, and could they make the objects move. Two subjects who did not understand the concept of real movement were replaced.

All subjects were given a classification test which involved labeling each picture as "moving" or "standing still." The exercise was carefully explained to each subject; he was told that if any picture seemed as though it were moving, or as though it were supposed to be moving, even a little bit, it should be classified as moving. The subjects were handed one picture at a time--a different random order was used for each subject--and the experimenter (the author) asked the

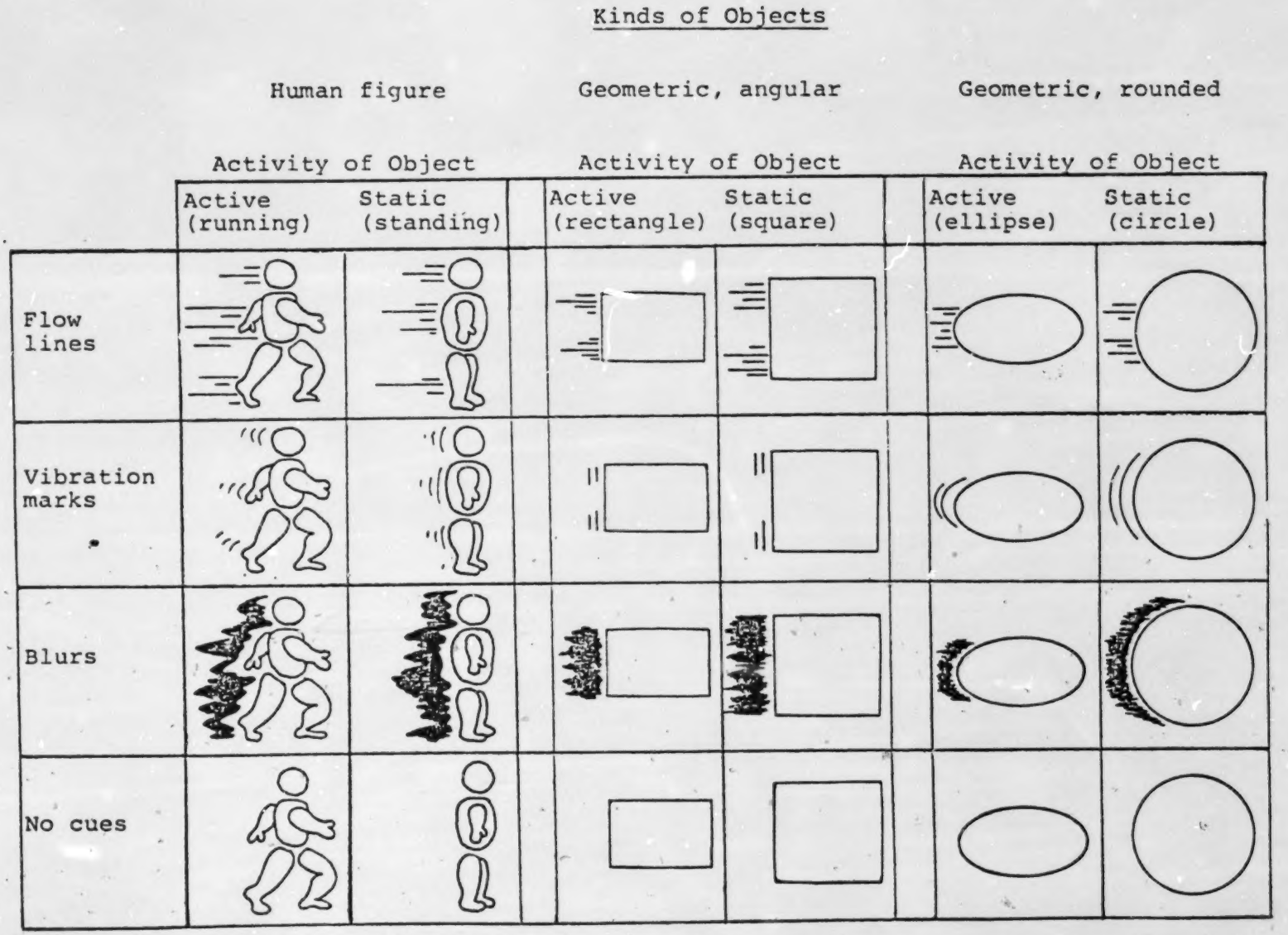


Figure 2. Illustration of pictures used in study.

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children whether they thought that the thing in the picture looked like it was supposed to be moving or standing still. The experimenter recorded an M on the picture if the object was described as moving, or an S on the picture if the object was described as standing still.

After the test was completed, the 24 cards were gathered and stapled in the same sequence as presented, and the experimenter interviewed each student. The interview was informal, and students were asked to explain the reasons for their classifcations. The experimenter's expectations were that the older children would identify the graphic conventions, whereas the youngest children would probably pay more attention to the nature of the object. The dialog would provide additional insights into how children read the pictures. (Hengen suggested that extensive interviewing be conducted to facilitate understanding the thought processes involved when a subject interprets an illustration (1970, pp.48-49). It is also the technique used by Piaget.)

Appendix A contains the raw data used in this study. Each object/motion cue picture identified as moving received a score of 1, each identified as standing still scored 0. An age group x sex x kind of object x activity of object x motion cues analysis of variance, with repeated measures on the last three variable, was used to analyze and evaluate the data (Winer, 1971). The experimental design is shown in Figure 3.

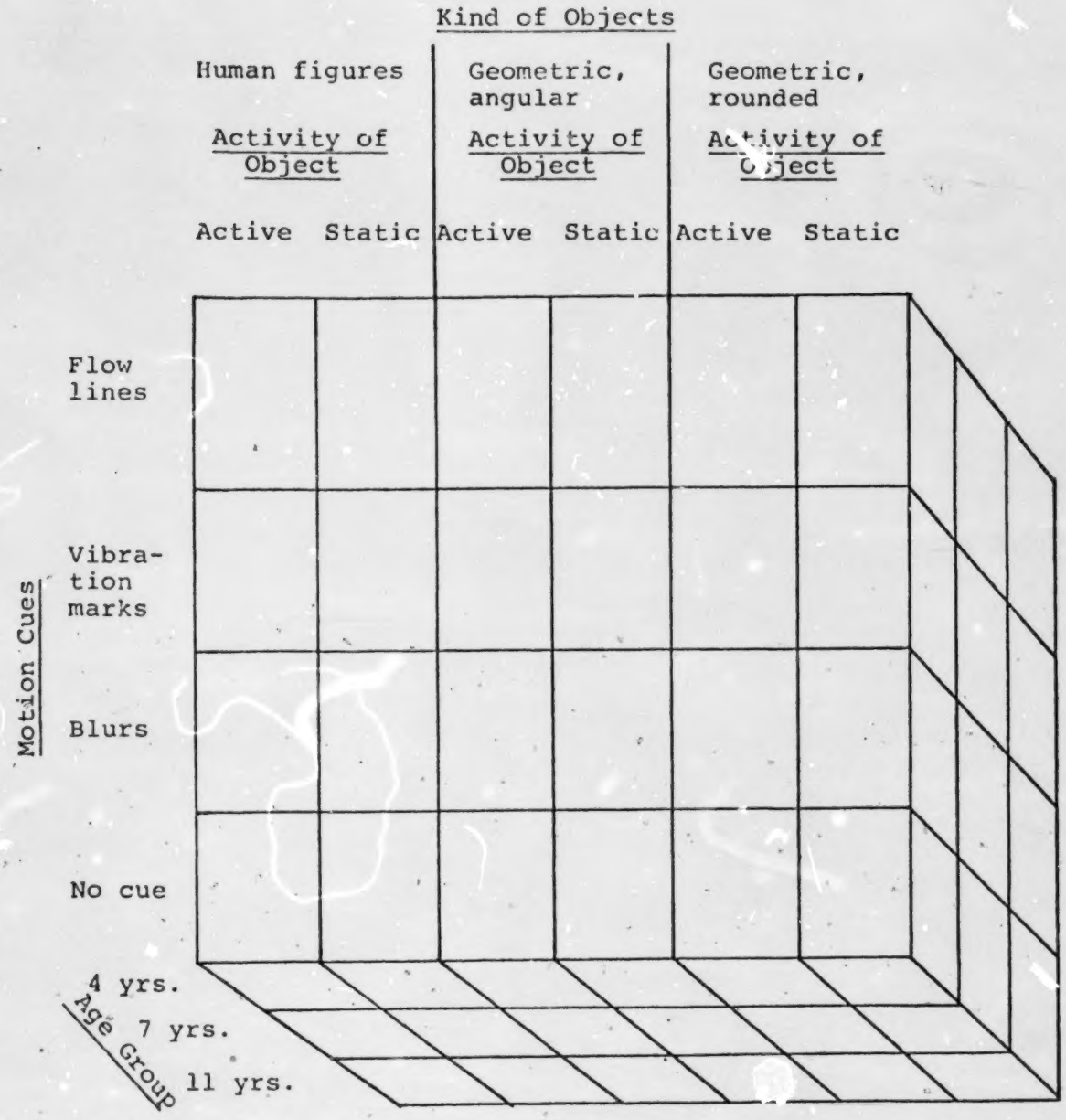

Figure 3. Illustration of experimental design.

Results and Discussion

The analysis of variance showed neither the main effect of sex nor its interactions with other variables were significant. To simplify the presentation of the results, a second analysis was done from which the variable sex was excluded. The results of the first analysis will not be discussed. The summary of the second analysis is shown in Table 1. As shown in Table 1, all main effects and interactions were significant.

The primary concern of this study was to see how a child's stage of development is related to his ability to perceive or "read" conventional graphic devices described here as implied motion cues. Additionally, it was speculated that both the kind of object and the object's inherent motion characteristics might be differentially related to the manner in which children at different stages of development interpret intended motion symbols. The four-way age group x kind of object x inherent activity of object x implied motion cue interaction, illustrated in Figure 4, seems to provide the best framework within which to examine the outcomes of this study. All lower level interactions appear to support the observations made based upon the higher order interaction without adding new insights and, therefore, will not be addressed specifically.

Because of the complexities involved in relating the results of the four-way interaction, the discussion which follows will be presented in the following manner. The human figure will be discussed first because of its dramatic contrast to the other kinds of objects in its active dimesion, and because of the

Table 1

Summary of Analysis of Variance

Source	df	MS	F
Age Group (G)	2	26.15	55.86*
Error	87	.46	
Object (O)	2	13.29	87.76*
O x G	4	1.76	11.65*
Error	174	.15	
Activity (A)	1	26.88	260.36*
A x G	2	.87	8.47*
Error	87	.10	
O x A	2	28.58	263.93*
O x A x G	4	.82	8.19*
Error	174	.10	
Motion Cue (C)	3	25.19	122.92*
C x G	6	4.43	21.63*
Error	261	.20	
O x C	6	1.42	17.34*
O x C x G	12	.42	5.11*
Error	522	.08	
A x C	3	.66	11.81*
A x C x G	6	.12	2.19**
Error	261	.05	
O x A x C	6	.37	5.59*
O x A x C x G	12	.20	3.07*
Error	522	.06	

*$p < .001$

**$p < .05$

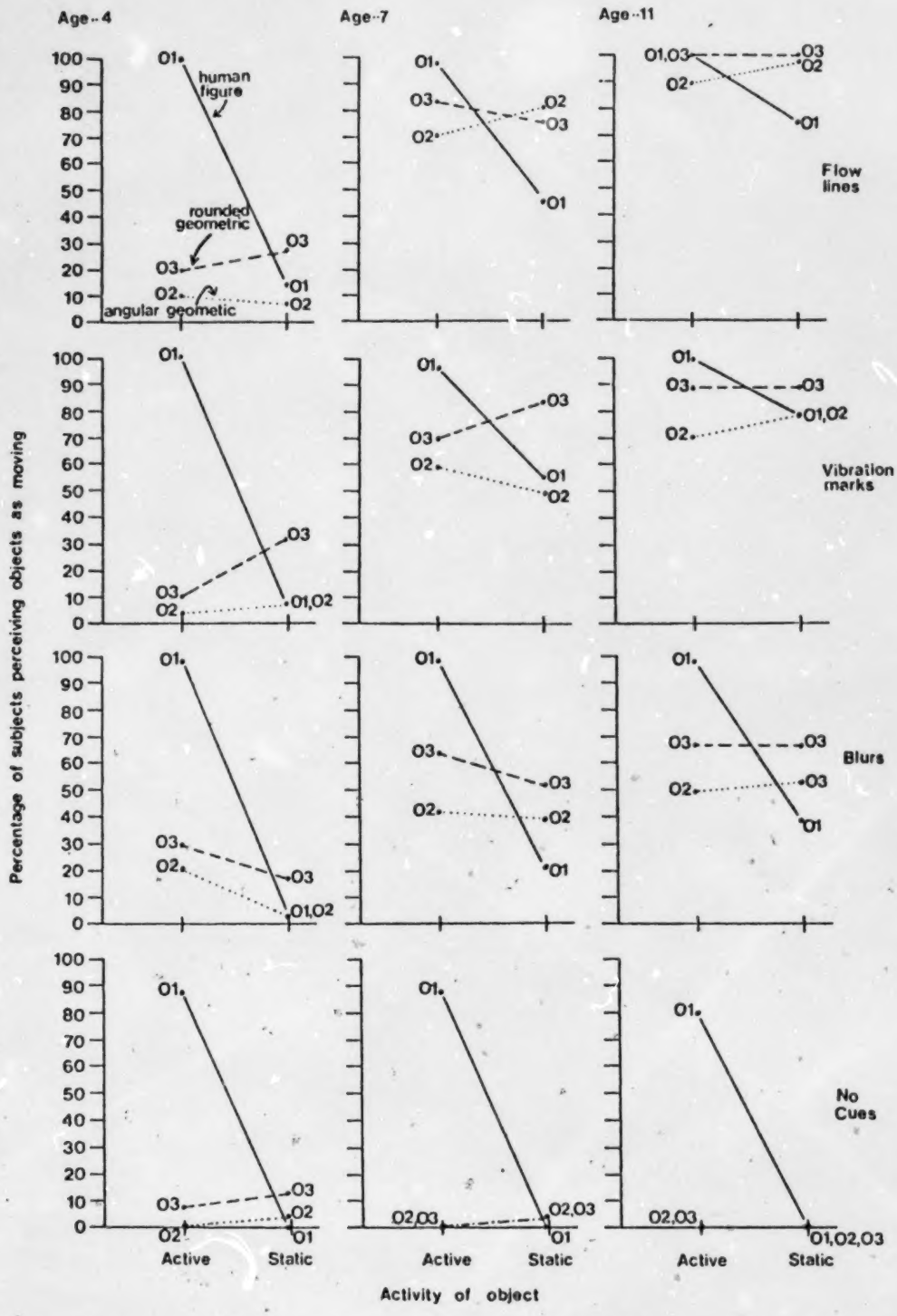

Figure 4. Illustration of the four-way interaction: age group x kind of object x activity of object x motion cue.

variable affect age seemed to have upon reading of motion in its static dimension when motion cues were added. Following that, because developmental level and the reading of motion cues were of primary interest to the study, observations will be made about what has been learned about the age group and motion cue variables. Then observations will be made about the more abstract geometric shapes and their inherent activity--as they relate to each other as well as to other variables. Conclusions will be stated and suggestions for further research will be advanced.

Reading the Illustration of the Four-way Interaction

A guide to reading the four-way interaction is presented in Figure 5. The reader is advised to examine that figure before exploring the illustration of the four-way interaction in Figure 4.

Reading the graphs in Figure 18 from left to right demonstrates the different ways in which the three age groups reported perceived motion for a given object type and activity state. Reading from bottom to top shows how the addition of a particular motion cue may have altered those perceptions.

Human Figure

One dramatic result was that the active (running) human figure was almost always seen as moving, regardless of either age of subject or motion cue applied. The running figure, or action pose, clearly possesses inherent motion information for all age groups studied.

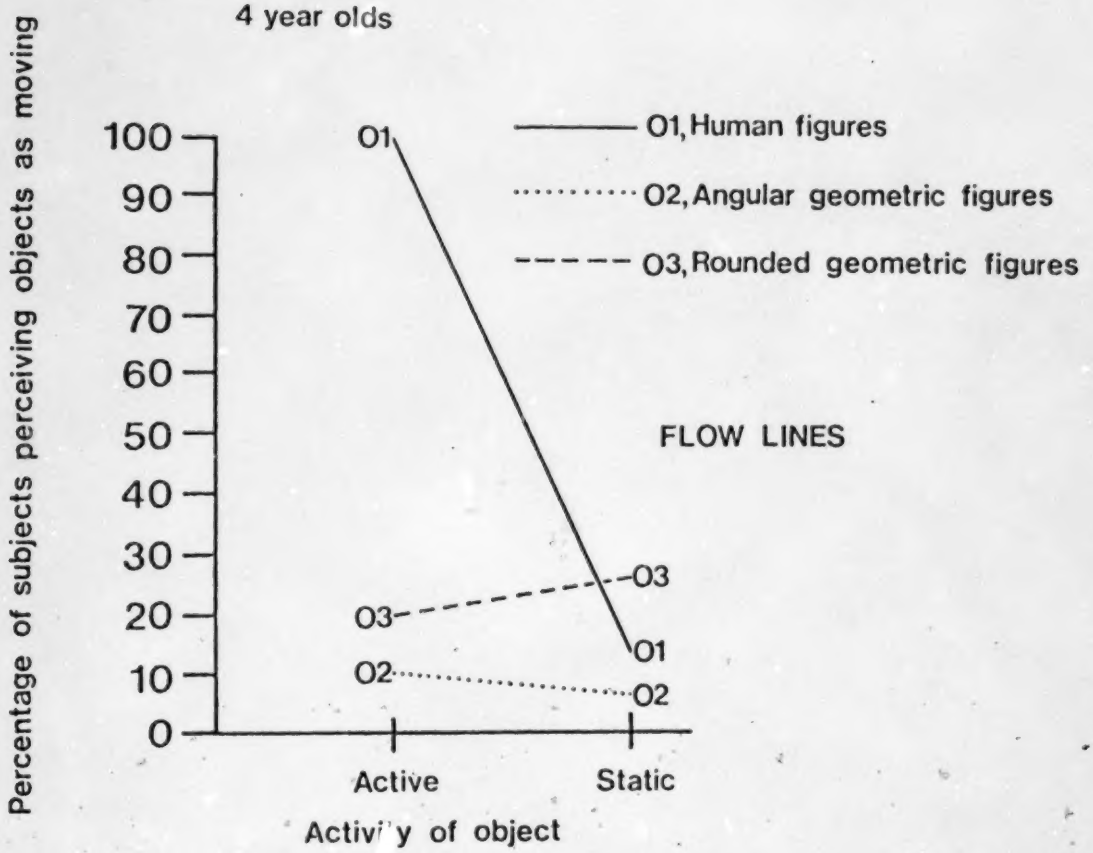

Figure 5. Guide to reading illustration of four-way interaction. The graph in this figure is the same as the graph in the upper left corner of Figure 4. It shows the percentage of 4 year olds who perceived pictures as moving when flow lines were added to each of three objects, for either of two activity states. The solid black line shows that, in the presence of flow lines, 100% of the 4 year olds saw the active (running) human figure as moving, while 13% saw the static (standing) human figure as moving. The dotted line shows that, in the presence of flow lines, 10% of the 4 year olds saw the active (rectangle) angular geometric figure as moving, while 6% saw the static (square) angular geometric figure as moving. The dash-line shows that, in the presence of flow lines, 20% of the 4 year olds saw the active (ellipse) rounded geometric figure as moving, while 26% saw the static (circle) rounded geometric figure as moving.

The static (standing) human figure clearly presents quite different information. Although it is almost consistently reported as having less motion information than the other static figures--square and rectangle--the addition of motion cues apparently differentially affects the amount of motion perceived by children at different stages. All three age groups reported no motion for the static figure under the no cue condition. As any one of the kinds of cues was added, however, the two older groups reported that the standing figure was "moving." The pre-schoolers, on the other hand, reported almost no motion.

This latter result seems reasonable. It would be totally inconsistent with reality and most experience for yound children to assume that a standing human figure, feet together, body rigid, was moving. The presence of abstract motion cues apparently did not override "no-motion" signals inherent in the standing figure. The fact that in most cases the older children reported less motion for the static human figure than for the static geometrics (although the statistical significance of this was not tested) may be an indication that even these children were a bit reluctant to identify a "standing" figure as "moving."

Age Group and Motion Cue

In general, the four-way interaction seems to reflect the fact that with increasing age the various motion cues had an increasingly heterogeneous effect on the perception of motion as the motion cues added were, respectively, blurs, vibration

marks, and flow lines. The percentage of subjects perceiving the five objects (other than the running figure) as moving in the graphs in Figure 4 for the seven and eleven year olds increases with respect to that same order of addition of motion cues, while the four year olds' graphs remain essentially unchanged from the no cue condition. An explanation consistent with this observation would be that the older children were "reading" the cues, while the pre-schoolers were ignoring them, centering their attention on the object depicted.

In interview conducted by the author with the students following the administration of the experiment, the older groups frequently explained that things seemed to be moving because of "the lines", or motion cues. Only one four year old identified the lines at all. That the older children were probably "reading" the cues is also suggested by the differential effect the various cues apparently had. For the seven and eleven year olds flow lines and vibration marks seemed to be more effective than the blur motion cue for most objects. This is plausible because the interviews revealed that the blur was probably a more ambiguous cue than the other graphic conventions. It received the widest range of interpretations, several inconsistent with motion interpretation. Some saw it appropriately as a "bunch of little lines close together, really moving fast." But others saw the blur as a "tornado", or "air pushing", or merely as "a wall", or "a shadow." Perhaps in the absence of contextual clues the blur motion cue as drawn for this study was a more confusing sign than were the

other two graphic cues. The fact, however, that even a poorly drawn cue was reported on the average more than 50 per cent of the time as contributing to motion interpretation may be further evidence that pictorial literacy has advanced enough by the age of seven to differentiate the older groups from the nursery school children.

Object and Activity

The power of the running human figure as a motion indicator has already been discussed. A closer look at the percentage of subjects perceiving movement in the geometric figures suggests that the variance between the two kinds of geometric shapes could be chane variation. In all but one instance (see the top center graph in Figure 4) rounded geometrics were perceived as moving more than angular geometrics, regardless of activity state inherent in the objects; the almost horizontal slopes and sometimes nearly parallel nature of the lines in Figure 4 suggests that differences between classes of geometric objects were not very meaningful.

Similarly, the percentage of subjects perceiving movement in the geometric figures suggests that the variance within the activity dimension could also be chance variation in most cases. This is almost surely the case regarding the active figures--ellipse and rectangle--and usually the case regarding the static figures--circle and square. It is possible, however, that under certain conditions (see, for example, the seven year old/vibration mark graph in Figure 4) the circle may be a better motion indicator than the square, albeit the statistical significance

of this was not tested.

In interviews conducted by the experimenter several of the four year olds expressed some ideas about the geometric objects which may explain some of the differences between subjects' responses to geometric objects--both active and static--and to the active human figure. Comments like "a square can't move" were very common among the pre-schoolers. They also said that "the man is running" or "the man is jumping." This may indicate that as four year olds look at the geometric shapes, perhaps some intuitive ideas about friction or inertia are operating.

Conclusions

The results of this study seem consistent with the findings of Friedman and Stevenson (1975). In both studies, younger and older subjects did not classify pictures in the same manner. Reliance on implied motion cues apparently does increase with age.

The current study, using seven year olds rather than six year olds, seems to establish more precisely the time period when children may begin to "read" motion cues. Friedman and Stevenson found that four and six year olds--both within the pre-operational stage--saw most postural pictures as "moving" and that they did not see any difference in the way graphic devices affected motion perception. Sixth graders and college students classified approximately the same number of postural pictures with or without motion cues as "moving" (p. 777). The

current study found the behavior of seven and eleven year olds--at the beginning and end of the concrete operations stage--to be more like each other than like the behavior of the pre-operational four year olds. It may be that by the time youngsters enter the concrete operations period they have the ability to "read" conventional motion cues, but not much before. The current study used geometric shapes as well as postural figures; Friedman and Stevenson used only the latter. That the older children seemed to attribute a substantial amount of motion to both kinds of objects when motion cues were used may support and emphasize Friedman and Stevenson's suggestion that once implied motion cues are learned, they assume the same power in eliciting a reading of movement as do action pose kinds of cues.

Comparisons with the Satterthwaite study (1965) must be more conservative. Satterthwaite was concerned with the quality and degree (i.e., smoothness, speed and distance) of motion as reported by college students. Although some similarities seem to exist between the studies--rounded objects were generally seen more often as moving than were angular ones, active and static geometric figures seemed to have similar amounts of motion information, and the running figure was always more potent than the standing figure--tests for simple effects were beyond the scope of either study.

The facts which do seem to emerge clearly from this study are that the active human postural figure was understood by the children in this study, regardless of their age group, as moving with or without the addition of motion cues, and that once the

children left the pre-operational stage of development they apparently had the ability to "read" the implied motion cues used in this study. The implication for message designers in general and for those interested in illustrating books for young children in particular seems clear. The differences between children's ability to understand implied motion cues at their respective stages of development ought to be taken into account when producing pictorial materials.

Suggestions for Further Research

Other selected motion cues. Only three implied motion cues were selected for this study, and one of them--the blur--was apparently more ambiguous than the other cues, perhaps because it was poorly drawn. A study using additional motion cues, or variations of the cues used in the present study could be developed. The relative power of different cues to elicit motion interpretations from pictorially literate subjects could be explored.

Contextual clues. All of the pictures used in the current study were essentially context-free and in that sense were unrealistic. It would be interesting to further test Stevenson and Friedman's hypothesis--that pictorial cues with structures very similar to structures in the three-dimensional world would be easy to interpret, but that pictorial cues less than isomorphic with reality would be more difficult to interpret (p. 773)--using more lifelike pictures and settings than were used in the current study. For example, Figure 6 shows a boy on a bicycle.

Figure 6. Illustration of Robert McCloskey's cartoon technique. Note the artist's use of flow lines. From Make Way for Ducklings, by Robert McCloskey, copyright (c) 1948. By permission of the Viking Press, Inc.

Most readers would agree that he and his bicycle are supposed to be in motion. The illustrator, Robert McCloskey, has provided many motion cues. Although the cartoon technique, including the use of flow lines, is an abstraction of reality, there are enough lifelike cues such as the boy's position on the bicycle, his tie, shirt-tail, and hair flying to assure that most readers would acknowledge that the boy and the bicycle are "moving." One could, however, manipulate this drawing, maintaining some contextual clues while eliminating others. Would some readers, for example, think that the boy and his bicycle (in Figure 14) were moving if the boy were drawn sitting erect, his back perpendicular to the ground, his feet on the pedals? Would this be the contextual equivalent of the standing figure in the current study?

In the current study, in the absence of contextual clues, it appeared that pre-schoolers ignored, for example, the flow line motion cue. Would a young child be more likely to "read" a flow line if it helped him to interpret the picture within a specific context? Imagine a drawing of a boy in the process of climbing a flagpole. Might the placement of flow lines above or below the boy be used to indicate if he was climbing up or down the pole, and would young children use such cues to decide the direction of motion? Experiments could be designed to explore these and similar questions.

Satterthwaite follow-up. Satterthwaite explored several ideas which the current study did not. It would be interesting to submit to a more rigorous statistical treatment questions

about perceived tense (e.g., in the presence of different cues, or of cues of greater length or thickness, does an object appear to be about to start, already in motion, or about to stop?); speed (e.g., does an object in the presence of one implied motion cue appear to be moving faster than the same object in the presence of another implied motion cue?); or quality of motion (e.g., which motion cues are best used to indicate erratic motion; fluid motion?).

Survey of artists. It would be interesting to survey artists to find out what kinds of assumptions, if any, they make about children's pictorial literacy, and to ascertain what techniques they would use under what conditions to imply motion. They might be asked if they attempt to adapt their techniques to various audiences, or if they would modify their style if it were demonstrated that groups of readers responded in different ways to different styles. A survey instrument could be designed to learn more about the community of children's book illustrators, and these and other questions could be asked to learn more about the concerns and attitudes of this group of "message designers."

Summary

This study reports an investigation of how children at different stages of development understand implied motion cues. The function of these cues is to represent motion in non-motion media (i.e., children's books, textbooks, magazines, and newspapers). The implied motion cues selected for this study were the flow line, the vibration mark, and the blur.

Problem

Prior research was examined which had shown that visually encoded messages communicate in a manner similar to verbally encoded ones. How well a person understands the significant verbal symbols of a language and their temporal and spatial arrangement is a measure of one's verbal literacy; how well a person understands a language composed of visual symbols and their spatial arrangement can be said to be an index of one's visual literacy. The present study was interested in what might be called pictorial literacy and more specifically, with respect to a particular element of pictorial communication, namely, implied motion cues.

People are not born literate. Through a combination of factors, including development, general experience, and formal education, people eventually learn to decode written and drawn messages. Extrapolating from Piaget's theory of cognitive development, it was suggested that a parallel exists between the development of spoken language-symbol systems and the development of other-symbol systems, specifically, pictorial

motion symbols. According to this view graphic conventions such as flow lines and vibration marks used by artists to depict motion would have little or no meaning to pre-operational (pre-school) children, but that an action pose, being more like real human posture, would be a symbol within the grasp of understanding of children within this group. By the beginning of Piaget's concrete operations stage, about seven years of age, most children whould be capable of understanding arbitrary graphic signs, and by age eleven virtually all should be capable.

It was further suggested that the kind of object upon which a motion cue is said to act might also affect perception of movement. Human figures, for example, are more likely to appear to be in motion than are geometric shapes such as squares or circles. It was speculated that an inherent motion factor may also be said to reside within an object, such that it appears to be more active or more static--e.g., running figures, ellipses and rectangles may be seen as more active than standing figures, circles or squares.

Three questions were posed.

1. Do children as they grow older attend to flow lines, vibration marks, and blurs and do they read them as motion devices?

2. Is one selected implied motion cue perceived more often as containing motion information than is another selected implied motion cue by children as they advance from the pre-operational stage to the concrete operations stage?

3. Do certain inherent characteristics of the kind of objects being acted upon differentially affect the communicative power of selected implied motion cues as reported by children as they mature from the pre-operational to the concrete operations stage?

Methodology

Subjects. Ninety primarily middle class subjects--30 four year olds, seven year olds, and eleven year olds--were selected arbitrarily from schools in Evanston, Illinois.

Procedures. An experimental study was conducted in an attempt to determine how children at different stages of development perceived implied motion cues in combination with a variety of objects. Each subject was shown the same 24 pictures which were arranged in different random orders for each child. There were three kinds of objects--human figures, angular geometric, and rounded geometric--each with an inherent active and static dimension. Each of these pictures appeared with one of three motion cues and alone. The number of each of the picture types identified as moving by each subject was determined. An age group x kind of object x activity of object x implied motion cue repeated measures analysis of variance was used to evaluate the data.

Results and Conclusion

All main effects and all interactions were significant. The four-way interaction, $F(12, 522) = 3.07$, p .001, was illustrated and used as the basis for presenting the results.

The data seemed to show clearly that the active human

postural figure was understood by all children in the study as "moving" with or without the presence of motion cues. The pre-operational children appeared to attend to only the kind of object, the action pose being the only object type for which significant movement was reported. Motion cues seemed to have no effect for this group. The older groups both reported apparently similar motion increases for all object types and activity states when motion cues were added--except that the active human figure remained consistently high. It was not determined whether any motion cue was significantly more effective than any other, although the blur appeared to be a somewhat weaker motion signifier in this study. This result may have been due to the blur's being rather poorly drawn.

It was concluded that once children leave the pre-operational stage they apparently have the ability to "read" the implied motion cues used in this study. The implication for message designers is that this differential ability ought to be taken into account when producing pictorial materials for children.

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